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TRANSLATOR'S AFFIDAVIT

I, Herbert Dubno, a citizen of the United States of America, residing in Bronx (Riverdale), New York, depose and state that:

I am familiar with the English and German languages;

I have read a copy of the German-language document attached hereto, namely PCT/DE2003/002845; and

The hereto-attached English-language text is an accurate translation of the above-identified German-language document.

Herbert Dubno

Sworn to and subscribed before me
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TRANSLATION

DESCRIPTION

METHOD AND DEVICE FOR CONTINUOUSLY CASTING METALS

The invention relates to a method for the continuous casting of metals or metal alloys, especially copper or copper alloys in which the liquid metal [molten metal] is conducted from a heating vessel through a casting nozzle in the casting pool of a continuous casting apparatus which is provided with a continuous casting [traveling] mold.

The invention additionally relates to a casting device for the continuous casting of metals, comprised of a furnace, a device for transferring the molten metal and a traveling mold.

Casting processes which are known from the state of the art feed the molten metal continuously to an open tundish and from there by an overflow process to the casting machine. This has the drawback that the liquid metal before solidification comes into contact with air so that metal types which have an affinity for oxygen or hydrogen cannot be cast in this manner.

However, even when the mentioned affinity is relatively limited or access to air is limited by an enclosure, which can be very expensive, it is necessary to reckon with a partial evaporation of the more volatile alloying components.

A further disadvantage is that in an overflow process through which the liquid metal flows into a traveling mold, there are control problems and the flow cannot be readily influenced or regulated. As a result undesired turbulence can occur which also contributes to the danger that oxidic or gaseous inclusions will be formed in the cast strand and that there will be an undesirable distribution of the molten metal and of the heating effects and the distribution of the alloying elements in the strand. It is also advantageous that during the casting process a residue of the molten metal will remain in the tundish and, following the casting, must be removed therefrom. This emptying of the tundish possesses a risk to the operators.

It is the object of the present invention to obviate the aforedescribed drawbacks and correspondingly to improve a method and a device of the type set forth at the outset.

These objects are achieved from a method point of view by the features according to claim 1. According to the invention, the discharge or pouring nozzle for the molten or liquid metal is configured as an immersion tube or dip tube that extends into the

casting pool or bank which is formed from the molten metal by the traveling mold. By contrast with a vertical continuous casting, from which this feature is basically known, the formation of a solidification front in the casting process utilizes a pair of substantially recumbent belts to define the traveling mold between them, the immersion tube will extend into the pool formed on the lower belt and between the two belts and close to them thereby allowing better outflow of the liquid. The unreliable flow which has hitherto been feared in a system such as that proposed in DE 37 07 897 A1, in which the belts are inclined to the horizontal and which was controlled in that system by adjusting the inclination of the transport belts in the casting direction as a function of the casting speed and the parameters of the material cast, does not arise. Surprisingly it has been found that the melt flow is self-controlling when at the mouth of the traveling mold, a casting pool is formed into which the immersion tube opens. As a result, a contact of the melt with the outer air is largely limited. Furthermore, the flow velocity of the melt and thus the flow profile in the pool or bank above the immersion tube diameter as well as that above the level in the bath upstream thereof can be influenced as well by the metalostatic pressure which is established together with the cooling and solidification profile in the casting pool. These profiles are adjustable for example by controlling the depth of penetration of the immersion tube [immersion tube length], the form or shape of the outlet opening and the flow velocity which in turn influences the heat transfer to

the entraining mold walls. Since the cooling with traveling molds of this type is typically significantly faster than with oscillating molds, the liquid phase from the point of view of its duration is greatly shortened. As a result gravitational effects are largely transferred to the background and the flow profile (including backflow) or the cooling efficiency are of greater significance.

Advantageously, the immersion tube is matched in its inclination to the state of the casting or melt level and is optionally adjusted in a feedback relationship therewith. The traveling sides of the mold are inclined according to a further feature of the invention slightly with respect to the horizontal, preferably between 3° and 45°. Finally, the molten metal is preferably transferred directly from the furnace to the immersion tube, preferably under pressure. With the above described features, surprisingly surface flow in the melt and turbulence is significantly reduced and the danger of gas inclusions is thereby substantially minimized. The flow conditions and the rate at which the metal is fed can be controlled significantly better than has hitherto been the case. In addition, there is improvement even at the beginning of the casting since the start can utilize metal at the precise temperature or thermal state required from the pressure chamber. At the end of the casting or upon interruption, the pressure with which the melt is displaced is reduced or discontinued so that all of the metal in the forehearth or receiver

can flow back into the pressure chamber. For carrying out the method, one uses the casting device described in claim 5 which, according to the invention is characterized in that the device for transferring the molten metal is an immersion tube which is arranged to be movable along its longitudinal axis. This longitudinal and axial mobility is a precondition enabling the immersion tube always to be positioned at the desired immersion depth in the casting pool.

Preferably for positioning the immersion tube, spacing sensors are used which can be arranged on its outer surface. The spacing sensors with corresponding control ensure that as required the immersion tube will follow the changing level of the casting melt plane or surface and will center the immersion tube in order to maintain the described flow profile and exclude thermal short-circuiting to the traveling mold component.

According to a further feature, the immersion tube is fixed directly to the casting furnace, whereby the furnace is movable along a track or path inclined to the horizontal so that the immersion tube is displaceable through the movement of the furnace. With this feature, intervening vessels like the overflow tundish required in according with the state of the art can be eliminated. In addition, the inertia hitherto resulting from the feed system is reduced by the elimination of the transfer function of the tundish. A further improvement in the flow of the liquid

melt can be achieved when the immersion tube is arranged at an inclination to the longitudinal axis of the casting gap, i.e. the gap between the two traveling belts, and is movable. For this purpose corresponding positioning elements can be provided on the furnace frame by which the furnace with the immersion tube fixed thereto can always be brought into the optimum position.

An example of the invention is illustrated in the drawing. It shows

FIG. 1 a side view of the casting furnace together with a partial illustration of two cooled traveling mold sides in the form of transport belts; and

FIG. 2 an enlarged illustration of the immersion tube with reference to the casting pool.

The casting furnace 10 shown in FIG. 1 is equipped with inductive heating. A prehearth arm 11 extends from the casting furnace and has an inclined bottom surface 12. At the end of this prehearth arm, an immersion tube 13 is arranged which (see especially FIG. 2) projects so far into the casting gap 14 between the two cooled transport rollers of the belts 15, 16 that the belt end of the immersion tube 13 lies below the casting or melt level 17 of the pool formed between the two belts.

By the application of pressure in the gas space above the bath level in the casting furnace, the liquid molten metal is displaced into the prehearth arm and flows out of the immersion tube. At the end of the casting process, the pressure is relieved so that any liquid metal remaining in the prehearth arm will drain back into the furnace because of the inclined bottom surface 12. The entire casting furnace is so mounted that the inclination of the immersion tube as well as its relative position with reference to the cooled transport rollers 15, 16 are adjustable. For this purpose spacing sensors on the immersion tube and a control unit are provided. The casting gap formed by the transport belts 15 and 16 is inclined to the horizontal and runs at least generally parallel to the longitudinal axis 18 of the immersion tube 8.